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FINAL REPORT

RELIABLE DATA ON SUSTAINABLE WHEAT STRAW AVAILABILITY - STRAW PRODUCTION

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Final Report

Reliable Data on Sustainable Wheat Straw Availability – Straw Production

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1. Summary

Wheat straw and grain samples were collected from 24 fields in Saskatchewan. Lab analysis was done to determine the amount of grain, chaff, and straw for each sample. The amount of straw at different cut heights was also determined.

From the above data, the straw to grain (S/G) ratios for all fields were determined. Data analysis indicated that S/G ratio is affected by wheat type, location, and other factors. Suggestions for using the project results to predict overall straw availability were presented.

2. Technical Report

2.1 Introduction

The economics of growing wheat are marginal and many people are interested in extracting more value from the crop by utilizing the straw for industrial purposes. Examples of these uses are strawboard, pulping and ethanol plants. To accurately analyze the economic viability of a plant and to ensure straw supply is sustainable, it is vital that reliable data on straw availability exists. Maps describing straw availability on the prairies have previously been developed by PFRA. Because of the limited amount of data available, some assumptions of straw to grain ratio, straw recovery and the effect of variety had to be made. This project, along with two others, was carried out to provide current data on straw availability throughout Saskatchewan as a function of grain yield and to relate this data to the actual amount of straw realized after combining, baling and storage.

In this project, straw samples were collected throughout the province and lab tests were done to determine the amount of straw in the field before harvesting. The other two projects investigated the straw recovery and storage aspects of straw availability.

2.2 Project Objectives

The objectives of this project were to:

1) Collect samples of wheat complete with all straw from various areas of the province just before harvesting to determine the amounts of straw, grain, and chaff in each of the samples at different cutting heights.
2) Determine, if possible, how any factors such as variety, location and moisture affect straw to grain ratios.
3) Provide the collected data to other researchers so it can be used to update straw availability maps.

2.3 General Description

Wheat samples were collected in the field by cutting the plants at ground level using hand shears. The samples were then bagged, weighed, and stored.

Before lab tests were begun, each sample was dried in an oven with forced, electrically heated air. The samples were then reweighed and the heads removed by hand. The heads were threshed and the chaff separated using a small, electrically driven thresher and air and screen separator (Figure 1). The straw lengths were measured using a tape measure, and sections of the bottom of the straw were cut off using a serrated knife.

The sections of straw removed were weighed on a lab platform scale. All data was entered into a spreadsheet for analysis.

Figure 1. Grain Thresher/Separator.

2.4 Scope of Test

Samples of wheat plants were collected from six areas of Saskatchewan just before harvest. The six areas were Swift Current, Kindersley, North Battleford, Melfort, Yorkton and Indian Head. Within each area, samples were collected from four fields. An attempt was made to collect samples from varieties and types of wheat that were typical of the area. It was also attempted to collect samples from "average" fields for the area.

Within each field, eight samples were collected. An attempt was made to collect these samples in a reasonably random fashion and not to include obvious areas of high or low yield.

Each sample was collected by cutting the plants at ground level and then placing the plants in a jute sack. The area collected was three or four seed rows wide, and of a required length that would represent an area being one square metre.

Each sample was weighed soon after collection and then stored. The bags were then dried at 90°C for 24 hours and then the samples were processed. The heads were removed and counted to determine the number of plants, and then the heads were threshed and cleaned. The resulting grain was then weighed.

The average resulting straw length was measured, and then three sections of 10 cm each were cut from the bottom of each sample. Each 10 cm cut off section was weighed.

2.5 Results and Discussion

The average straw to grain (S/G) ratios for all eight samples taken in each field are given in **Table 1**.

Table 1. Average S/G Ratios.

Field Sample	Wheat Variety	Wheat Type*	S/G at 0 cm Cut Height
Melfort #1	Prodigy	CWRS	1.9
Melfort #2	AC Crystal	CPS	1.2
Melfort #3	AC Crystal	CPS	1.0
Melfort #4	AC Intrepid	CWRS	1.4
North Battleford #1	AC Crystal	CPS	0.8
North Battleford #2	AC Barrie	CWRS	1.5
North Battleford #3	McKenzie	CWRS	1.1
North Battleford #4	AC Barrie	CWRS	1.1
Kindersley #1	AC Barrie	CWRS	1.2
Kindersley #2	CDC Makwa	CWRS	1.0
Kindersley #3	Kyle	CWAD	0.9
Kindersley #4	Kyle	CWAD	0.8
Yorkton #1	AC Barrie	CWRS	1.4
Yorkton #2	AC Cadillac	CWRS	1.6
Yorkton #3	CDC Teal	CWRS	1.3
Yorkton #4	AC Cadillac	CWRS	1.6
Swift Current #1	AC Barrie	CWRS	1.4
Swift Current #2	Ac Barrie	CWRS	1.2
Swift Current #3	Kyle	CWAD	1.3
Swift Current #4	AC Avonlea	CWAD	1.1
Indian Head #1	Kyle	CWAD	1.6
Indian Head #2	AC Morse	CWAD	1.4
Indian Head #3	AC Elsa	CWRS	1.3
Indian Head #4	AC Barrie	CWRS	1.6

* CWRS – Canada Western Red Spring; CPS – Canada Prairie Spring; CWAD – Canada Western Amber Durum.

In the above table, the S/G ratio is expressed at a 0 cm cut height, which represents all of the available straw if cut at ground level. The actual amount of straw available will depend on the cut height. The ratios are also expressed at 0% moisture content (M.C.), which represents the amount of dry matter available. The actual mass of straw available would depend on the straw moisture content.

The data from **Table 1** is shown in **Figure 2**.

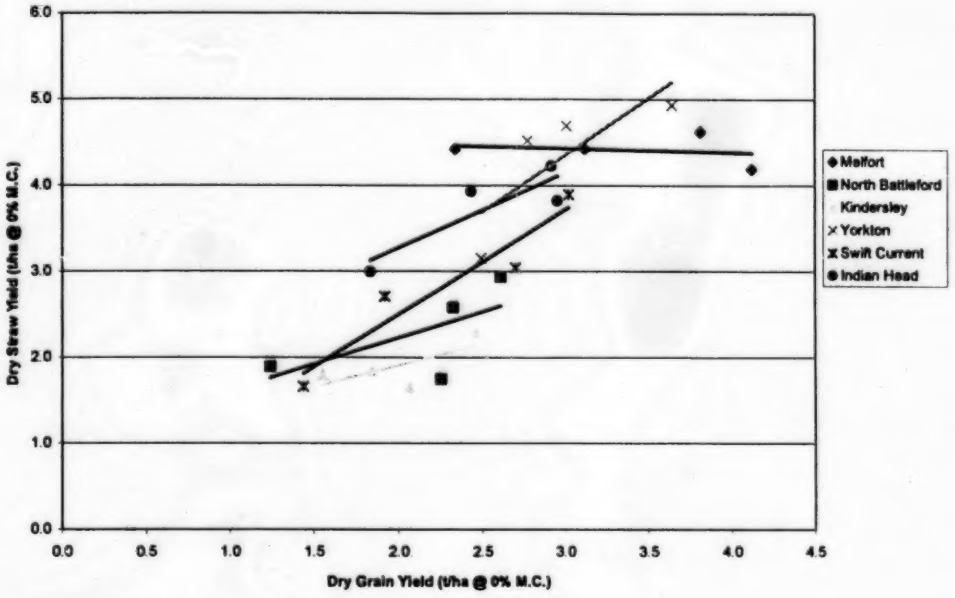

Figure 2. Straw to Grain Ratio by Location.

The results from **Figure 2** indicate that there are definite relationships between the S/G ratio and the location in the province. The one exception to this statement is that the straw yield for Melfort was the same regardless of grain yield. This could very well be due to only having sampled four fields, and should not be taken to indicate a definite trend. Although the results for other locations may not be statistically significant, they do indicate that the S/G ratio is dependent on geographical location. More extensive data collection would probably provide more accurate data.

Average S/G ratios for all locations are given in **Table 2**.

Table 2. Average S/G Ratios by Location.

Location	S/G Ratio
Melfort	1.4
North Battleford	1.1
Kindersley	1.0
Yorkton	1.5
Swift Current	1.2
Indian Head	1.5

As expected, the south and western parts of the province have less straw than the east and north areas. Swift Current typically has a drier climate than other areas, and Kindersley and North Battleford had a drier than normal year in 2000. The other areas of the province traditionally have more moisture than the south and west, and this was reflected in the straw production.

The average S/G ratio for each wheat type is given in **Table 3**.

Table 3. S/G Ratio by Wheat Type.

Wheat Type	Average S/G Ratio
CWRS	1.37
CWAD	1.20
CPS	1.00

Based on the samples collected during this project, it appears that CWRS wheat has a higher S/G ratio than CWAD and CPS wheat. CWAD had about 20% more straw than CPS wheat, and CWRS about 37% more than CPS, for a given mass of grain. This is consistent with the characteristics of each wheat type, as CPS wheat typically has a greater proportion of grain to straw than other wheat types.

The above data suggests that S/G ratio is affected by several factors, including location, wheat type, and probably others. Assigning methods to correct for all of the variables would aid in predicting straw availability for a given field. Wheat type will always be known (or given), but the data collected for this project only includes six locations in the province. Yield data for other locations is not available, but a method for using other existing data may make this process easier. It is probable that rainfall may be related to straw yield, grain yield, and/or S/G ratio. To investigate this, the average values for all fields were compared to the total rainfall for that area from April to August. Rainfall data was obtained from the Crop Report #30, published by Saskatchewan Agriculture and Food in October 2000. The results are presented in **Figure 3**.

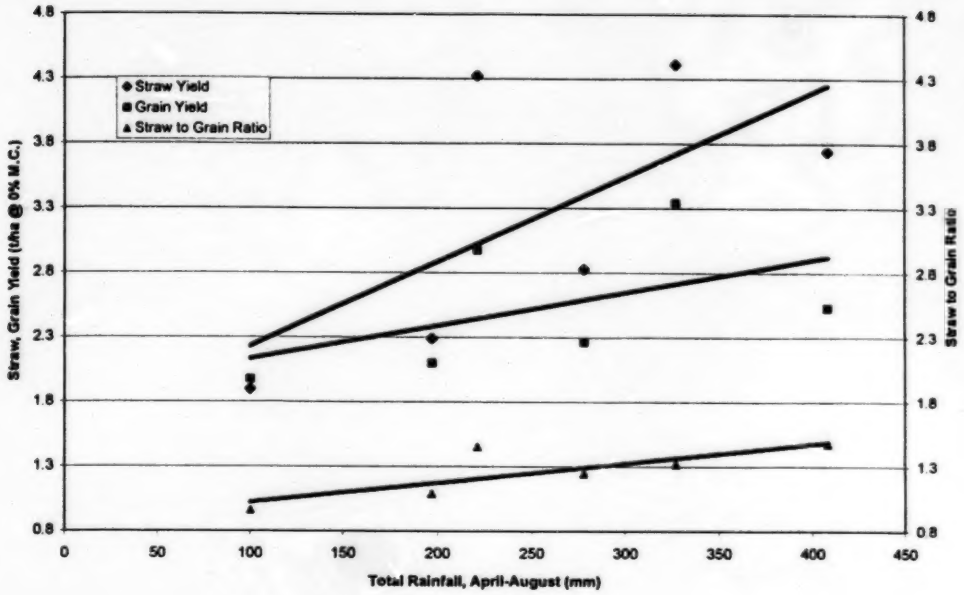

Figure 3. Yields vs. Rainfall.

There appears to be a relationship between straw yield and rainfall, as well as grain yield and rainfall. However, it appears that because of the wide variability in the data, using rainfall alone to predict straw or grain yield would not be very reliable. Except for one data point, it appears that total rainfall can be used to predict S/G ratio. Of course, more data would have to be collected to confirm this and to develop a statistically significant relationship, but the results from this project suggest further study is warranted.

To determine how much the straw mass would be reduced at different cutting heights, the percent of original straw mass remaining at different heights was calculated. This value was plotted against the percent of length remaining at different cut heights. The results of this comparison are shown in **Figure 4**.

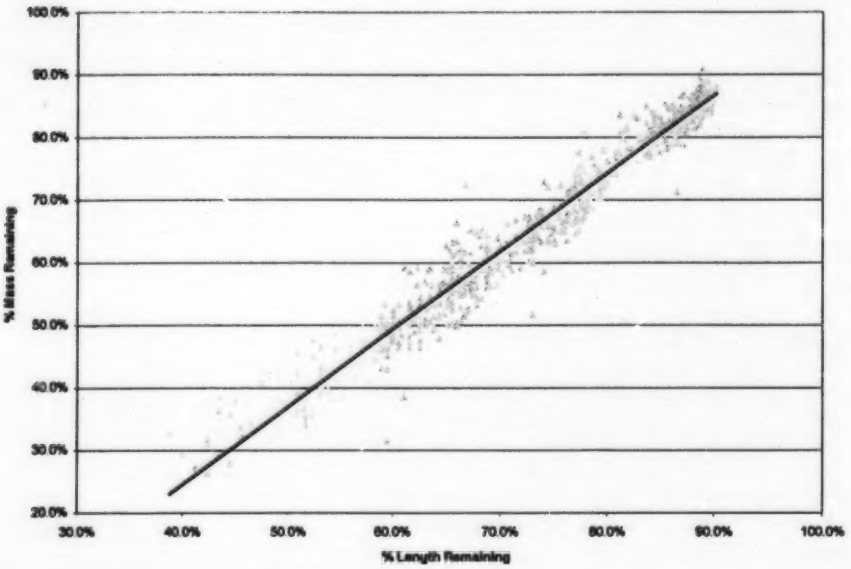

Figure 4. Straw Mass vs. Remaining Length.

The data shown in **Figure 4** indicates that there is a very good relationship between the percent of mass remaining and the percent of straw length remaining. Therefore, if the initial straw length and the cut height are known, the amount of remaining mass can be calculated or predicted. Because the data in **Figure 4** includes data from all fields sampled, it appears that this relationship is independent of wheat variety and geographic location. This is reasonable, as it should only be affected by the degree of taper of the wheat straw itself.

When the above methods are used to estimate straw yield, the result is the amount of dry matter available at 0% M.C. If the mass available at a given moisture content is desired, the final mass can be calculated.

Based on the above data and analysis, it appears that relationships exist that can be used to predict straw yield based on rainfall, straw type, straw height, and cutting height. More extensive sampling, including more locations over more crop years, would help to better define the relationships. Other factors, such as soil type, nutrient supply, the timing of rainfall, and net moisture may also be incorporated into a model to predict straw availability in the past or into the future.

6. Project Photos

Figure 5. Grain Sampling Processing.

Figure 6. Measuring Straw Sample.

7. Acknowledgement

A progress update from this project and the other two associated projects were presented at the Agriculture and Greenhouse Gas Climate Change Workshop in late 2000.

Appendix I

Field Locations

Field No.	Legal Land Description
Melfort #1	NW¼ 24-45-18-W2
Melfort #2	NE¼ 6-46-17-W2
Melfort #3	SW¼ 4-44-19-W2
Melfort #4	SE¼ 10-44-20-W2
North Battleford #1	E½ 13-44-16-W3
North Battleford #2	SW¼ 13-44-16-W3
North Battleford #3	NW¼ 8-43-14-W3
North Battleford #4	NE¼ 19-43-14-W3
Kindersley #1	S½ 30-28-22-W3
Kindersley #2	S½ 4-31-24-W3
Kindersley #3	S½ 33-29-23-W3
Kindersley #4	NE¼ 22-30-24-W3
Yorkton #1	S½ 26-25-2-W2
Yorkton #2	E½ 34-26-3-W2
Yorkton #3	SW¼ 24-26-6-W2
Yorkton #4	SW¼ 24-27-4-W2
Swift Current #1	N½ 34-13-13-W3
Swift Current #2	SW¼ 18-16-11-W3
Swift Current #3	NW¼ 20-15-14-W3
Swift Current #4	SW¼ 18-19-13-W3
Indian Head #1	NW¼ 31-18-12-W2
Indian Head #2	SE¼ 9-18-11-W2
Indian Head #3	SE¼ 32-18-11-W2
Indian Head #4	SE¼ 3-18-12-W2

Appendix II

Raw Data

Field	Wheat	Wheat	Plant	Sample	Dry Straw Yield (Mts) at cut heights				Dry Grain Yield	Wet Grain Yield	Dry Chaff Yield	MOG/G Ratio at Cut Heights				Straw/Grain (S/G) @ Cut Heights			
Sample	Variety	Type	Population	Moisture Content	0 cm	10 cm	20 cm	30 cm	(Mts)	(bu/ac) @ 14.5%	(Mts)	0 cm	10 cm	20 cm	30 cm	0 cm	10 cm	20 cm	30 cm
Melfort #1	Prodigy	CWRS	471	26.4%	4.4	3.8	3.2	2.7	2.3	40.6	1.5	2.5	2.3	2.0	1.8	1.9	1.6	1.4	1.1
Melfort #2	AC Crystal	CPS	489	33.0%	4.6	3.9	3.1	2.3	3.8	66.3	1.7	1.7	1.5	1.3	1.1	1.2	1.0	0.8	0.6
Melfort #3	AC Crystal	CPS	401	36.5%	4.2	3.4	2.7	2.1	4.1	71.7	1.7	1.4	1.3	1.1	0.9	1.0	0.8	0.7	0.5
Melfort #4	AC Intrepid	CWRS	481	26.1%	4.4	3.7	3.1	2.4	3.1	54.2	1.3	1.8	1.6	1.4	1.2	1.4	1.2	1.0	0.8
North Battleford #1	AC Crystal	CPS	272	28.5%	1.7	1.4	0.9	0.6	2.2	39.1	0.9	1.2	1.0	0.8	0.7	0.8	0.6	0.4	0.3
North Battleford #2	AC Barrie	CWRS	269	31.1%	1.9	1.5	1.1	0.7	1.2	21.5	0.8	2.2	1.9	1.6	1.2	1.5	1.2	0.9	0.6
North Battleford #3	McKenzie	CWRS	374	35.1%	2.9	2.4	1.9	1.5	2.6	46.3	1.0	1.5	1.3	1.1	0.9	1.1	0.9	0.7	0.6
North Battleford #4	AC Barrie	CWRS	336	37.3%	2.6	2.1	1.7	1.2	2.3	40.4	0.9	1.5	1.3	1.1	0.9	1.1	0.9	0.7	0.5
Kindersley #1	AC Barrie	CWRS	232	14.1%	1.8	1.5	1.1	0.8	1.6	27.0	0.7	1.8	1.4	1.2	1.0	1.2	1.0	0.7	0.5
Kindersley #2	CDC Meiwe	CWRS	331	13.8%	1.8	1.5	1.1	0.7	1.8	32.0	0.8	1.4	1.2	1.0	0.8	1.0	0.8	0.6	0.4
Kindersley #3	Kyle	CWAD	239	12.5%	2.3	1.9	1.5	1.1	2.5	34.3	0.9	1.3	1.1	1.0	0.8	0.9	0.8	0.6	0.5
Kindersley #4	Kyle	CWAD	166	20.7%	1.7	1.4	1.0	0.7	2.1	35.9	0.7	1.2	1.0	0.9	0.7	0.8	0.7	0.5	0.4
Yorkton #1	AC Barrie	CWRS	597	35.0%	4.9	4.3	3.7	3.0	3.6	63.4	1.3	1.7	1.5	1.4	1.2	1.4	1.2	1.0	0.8
Yorkton #2	AC Cadillac	CWRS	453	17.9%	4.5	3.9	3.3	2.8	2.8	48.2	0.8	1.9	1.7	1.5	1.3	1.6	1.4	1.2	1.0
Yorkton #3	CDC Teal	CWRS	459	17.5%	3.1	2.6	2.1	1.6	2.5	43.3	1.2	1.7	1.5	1.3	1.1	1.3	1.1	0.8	0.7
Yorkton #4	AC Cadillac	CWRS	497	31.0%	4.7	4.1	3.4	2.8	3.0	52.3	1.2	2.0	1.8	1.5	1.3	1.6	1.4	1.1	0.9
Swift Current #1	AC Barrie	CWRS	417	21.2%	2.7	2.1	1.6	1.1	1.9	33.4	1.1	2.0	1.7	1.4	1.2	1.4	1.1	0.8	0.6
Swift Current #2	AC Barrie	CWRS	251	25.7%	1.7	1.3	0.9	0.6	1.4	25.0	0.7	1.6	1.4	1.1	0.9	1.2	0.9	0.7	0.4
Swift Current #3	Kyle	CWAD	311	31.4%	3.9	3.3	2.6	2.0	3.0	52.5	1.1	1.7	1.5	1.3	1.1	1.3	1.1	0.9	0.7
Swift Current #4	AC Avonlea	CWAD	319	44.4%	3.0	2.5	1.9	1.4	2.7	46.9	1.0	1.5	1.3	1.1	0.9	1.1	0.9	0.7	0.5
Indian Head #1	Kyle	CWAD	361	38.6%	3.9	3.3	2.7	2.2	2.4	42.3	1.1	2.1	1.8	1.6	1.4	1.6	1.4	1.1	0.9
Indian Head #2	AC Morse	CWAD	349	30.9%	4.2	3.7	3.1	2.5	2.9	50.7	1.1	1.8	1.6	1.4	1.2	1.4	1.3	1.0	0.9
Indian Head #3	AC Elsa	CWRS	442	36.1%	3.8	3.3	2.7	2.2	2.9	51.3	1.3	1.7	1.6	1.4	1.2	1.3	1.1	0.9	0.7
Indian Head #4	AC Barrie	CWRS	399	25.7%	3.0	2.5	2.0	1.6	1.8	31.9	1.0	2.2	1.9	1.6	1.4	1.6	1.4	1.1	0.9

Appendix III

Rainfall Data

Location	Average			Rainfall								Apr.-Aug.
	Straw	Grain	SR	April	May	June	July	August	Sept.	October	Total	Total
Indian Head	3.74	2.53	1.48	47	76	133	86	63	34	0	442	406
Swift Current	2.83	2.27	1.25	29	39	71	128	11	41	13	332	278
Kindersely	1.90	1.98	0.96	0	13	43	27	17	47	7	154	100
Melfort	4.41	3.34	1.32	20	64	79	116	48	14	0	341	327
North Battleford	2.29	2.10	1.09	10	8	34	71	74	34	2	233	197
Yorkton	4.32	2.98	1.45	28	22	77	49	45	35	0	256	221